Brass Tacks

An in-depth look at a radio-related topic

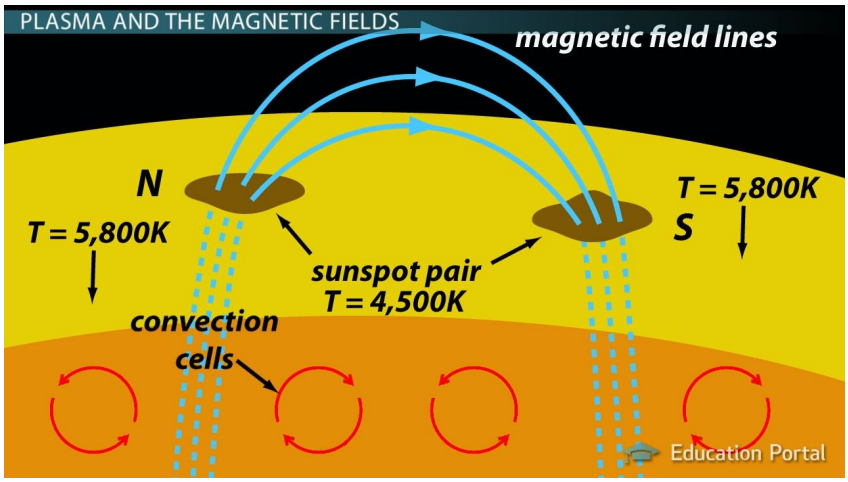
Effect of the Sunspot Cycle on amateur radio

On the web, over the air, in magazines, and at club meetings, hams are talking about the Sunspot Cycle. We've already addressed the importance of sunspots to propagation in a previous article of the *UVARC Shack* (Dec 2017, *Brass Tacks*), but maybe it's time to reveal a bit more. Numbers of sunspots typically affect ham radio operation of HF (high frequency) between 20 meters and 10 meters, and sometimes 6 meters, which collectively I'll call *mid-range HF*, because these frequencies appear near the middle of our ARRL Band Charts. Since most new hams confine their radio work to local VHF and UHF using FM, they're largely unaffected by sunspot activity, or the lack thereof. But those who work this mid-range HF are slaves to those sunspots, which come and go in periodic cycles.

Where do sunspots come from?

The Sun is a great, big ball of superheated gases that are continuously fed by a thermonuclear process, then cooled by heat transfer, resulting in swirling convections of very hot oceans of ionized plasma. The continuous heating-and-cooling cycle forces different latitudes of the Sun's surface to rotate faster than others (differential rotation), the closer to the equator, the faster the rotation. At the same time, the convections of these ionized oceans give rise to huge magnetic fields that align into "containment tubes" of magnetic flux, which then slowly create large energy cells under the surface.

Because of the Sun's size, the large energy cells take a couple of years to build and reinforce each other from minimum to maximum strength. They remain at maximum for several years, then take several more years to return to minimum, totaling about eleven years. But they strengthen in opposite polarity each time, actually making the effective period about 22 years. Since their polarity has very little effect on earthly radio propagation, we hams simply experience periods of the maxima and minima about every eleven years, whether it's north-aligned or south-aligned. During these years of high field orientation, the flux cells become sheared (cut up) by the differential rotation, allowing the contained magnetic flux to rupture out of them with enough force to escape (puncture) the solar surface tension, then return to the surface through another rupture.



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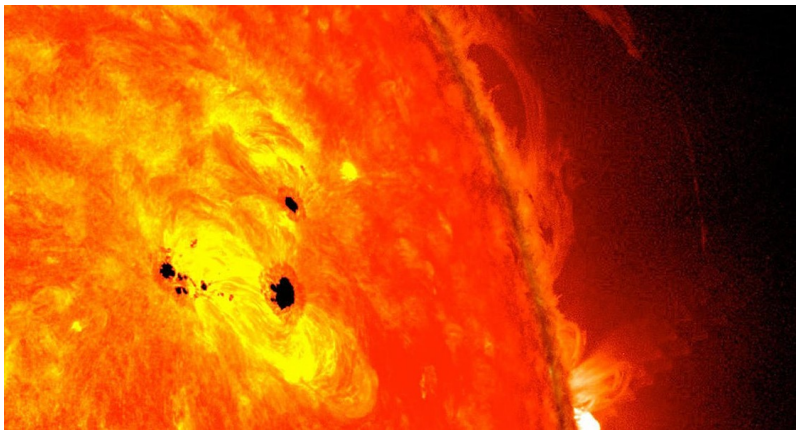
Many of these surface punctures can be seen from Earth as *sunspots*, whose lifetimes could extend anywhere from a few days to a few weeks. And the more highly aligned the magnetic flux collection within the tubes, the more explosively the magnetic tubes rupture, which results in not only larger sunspots, but more of them over the weeks, months, and years that they're strongly aligned. Furthermore, the containment tubes act as quantum field generators, meaning that, because they're formed by magnetic fields, they're subject to quantum electrodynamics, so that the energy going into the cells will emerge at a different frequency, not unlike the way fluorescent bulbs work. This gives rise to emissions of greater amounts of UV (ultraviolet) and X-ray radiation near sunspots than is typically given off at other surface areas.



Solar flux

The Sun sends a lot of this UV and X-ray radiation, known as *solar flux*, to the Earth and everywhere else in the Solar System. Turns out that if we measure solar radio noise at 2800 MHz (10.7 cm), this level reflects a strong correlation with the actual amount of solar flux that reaches our atmosphere. We call this measurement the *Solar Flux Index* (SFI) and *F10.7 Index*, measured in *solar flux units* (SFU), a very good indicator of prospective long-range radio communication on mid-range HF bands and overall solar radiation. The SFI scale typically ranges as low as 50 SFU to as high as 300 SFU, with 200 SFU being typical during the peak of the Sunspot Cycle. During one of those peaks we commonly hear about an SFI of 240 to 280 SFU reported. At the writing of this article (mid-2018) we're measuring the SFI at between 65 and 75 SFU, which is very low.

The huge amounts of UV radiation sent to Earth enhance the ionosphere, because atmospheric ionization of atomic Oxygen occurs much faster and more abundantly than recombination, contributing to higher levels of radio wave refraction within mid-range HF frequencies. So, those bands are highly affected by the Sunspot Cycle, such that the more sunspots that appear on the surface, the higher the SFI, meaning the more UV and X-ray radiation the Sun emits, the more refractive the ionosphere seems on those bands. This enhanced ionospheric refraction allows us hams to use those frequencies to communicate much longer distances, day or night.

An increasing number of amateurs work HF on CW, FT8, or other weak-signal modes, even now, when the sunspots are at a minimum. But those who love SSB (single sideband) find it difficult at the moment to get their signal out very far without a huge antenna setup, thanks to the lack of sunspots. They'll tell you that 10 meters is dead, and that they aren't able to hear any of the beacons. Well, when 2022 rolls around, you're going to hear a lot of those who bemoan the conditions today, gradually dry their tears, and start making a lot of offshore phone QSOs. The digital hams will still work their magic, but you'll likely hear a lot of reports of SSB contacts with Brazil and Chile on 10 meters.

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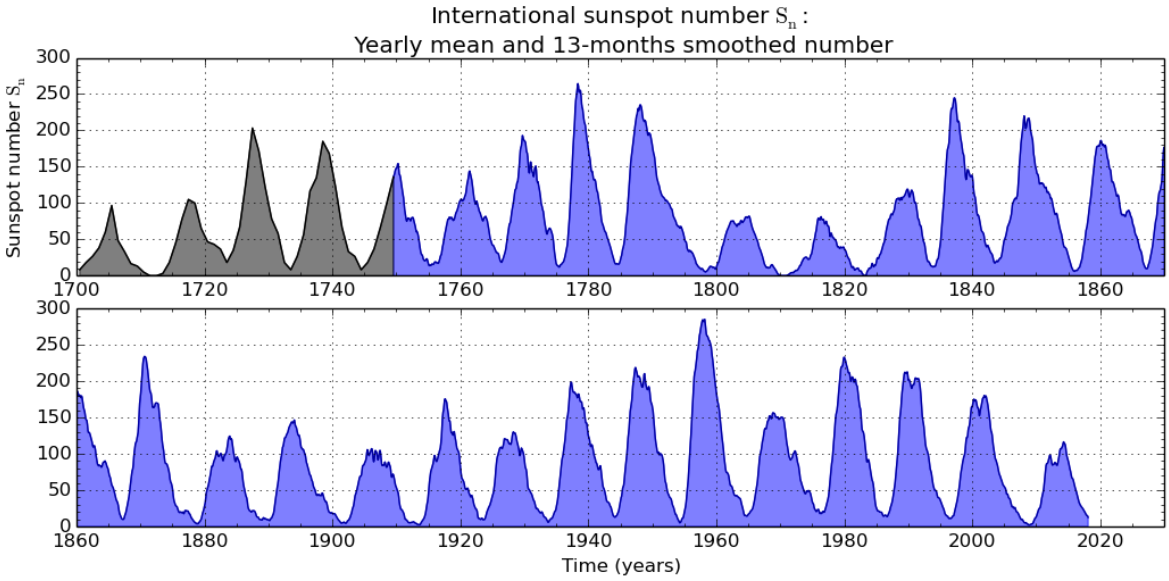
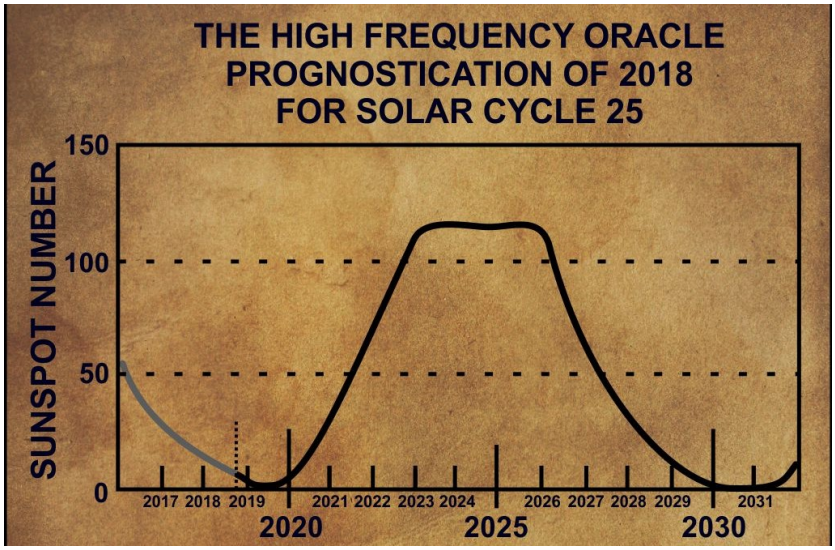
So, where are we now in the Sunspot Cycle?



Sunspot Cycles are named by the number of peak cycles since 1755, when we started seriously recording sunspot activity. Unfortunately, we're currently in a sunspot minimum, between Cycle 24 and Cycle 25. As can be seen by this Solar Cycle 25 prediction, we aren't actually expected to hit the low point until the middle of 2019, and then peak again between 2023 and 2026. So, if this prediction is accurate, we should start seeing the mid-range HF bands pick up about mid-2021. But keep in mind that, similar to weather forecasting, it's only a very rough prediction, with a large margin of error.



The Sunspot Cycle is just one factor that determines the band conditions. Others include solar flares and geomagnetic storms, which adversely affect HF propagation, and actually increase somewhat with sunspot activity, because they're also affected by solar flux. Other solar activity that impacts radio signals include the solar rotation, which measures about 25 days at the equator and about 34 days at the poles.

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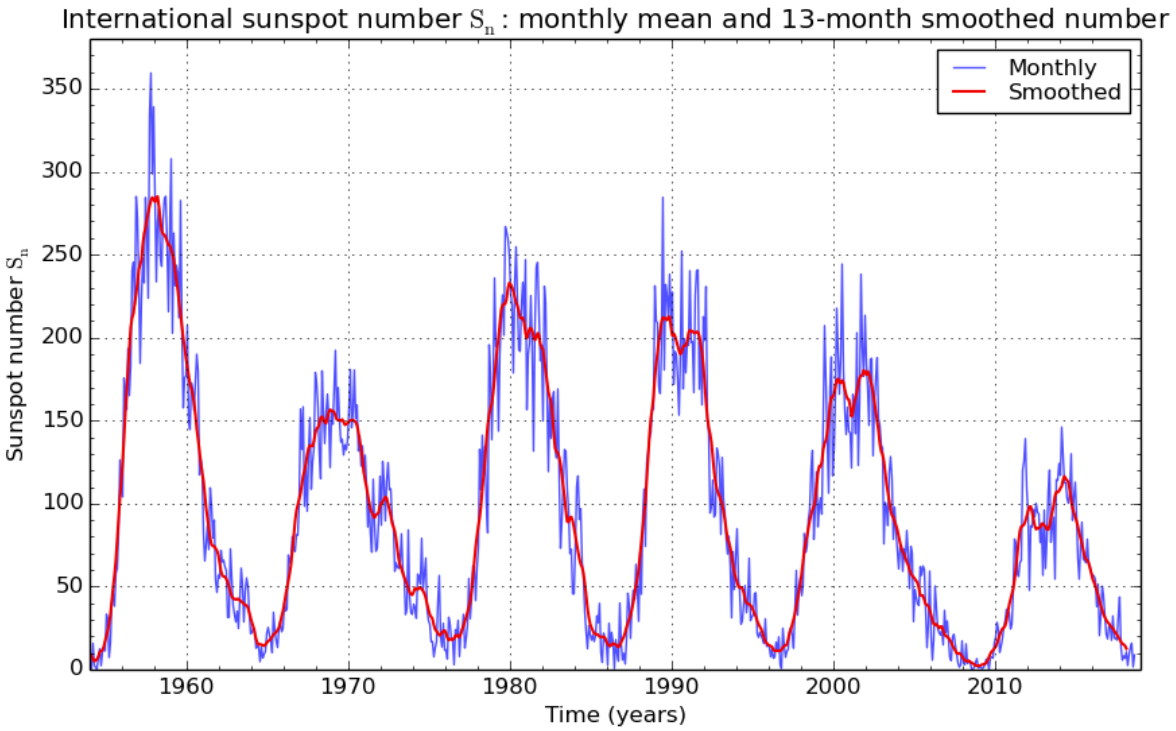

Another is weather, which typically has the least effect on HF and VHF band conditions, but tends to affect propagation more, as radio frequency increases beyond VHF. Then again, lightning and thunderstorms are the single largest contributor to atmospheric noise on HF bands. And there are others, such as daytime versus nighttime, and temperature inversions, but suffice it to say that our amateur radio experience is affected by many things, and the Sunspot Cycle plays a major part.

Want to keep up with solar info? Try SpaceWeather.com for daily updates

Want to know what NASA's take on all of this is? Visit the NASA Solar Page

Want to learn more? Go to the Stanford Solar Center on solar education for the regular person

Conclusion

So, should we put our HF rigs away for a few years, and wait until the Cycle peaks again? Of course not! You can purchase a SignaLink and get involved in digital communication. And don't forget that 80 meters and 40 meters, which are not quite so dramatically affected by the Sunspot Cycle, are still available for nighttime use. Hopefully, there'll be plenty of hams still awake when you'd like to talk with them on those low bands. And heck...maybe conditions are just right time to learn CW.

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